No. 27.

THE Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,
Director of Carleton College Observatory.

SEPTEMBER, 1884.

CONTENTS:

"He telleth the number of the stars; He calleth them all by their names."

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Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

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LARGE TELESCOPES OF THE WORLD.

THE EDITOR.

The *English Mechanic* and some other foreign scientific papers have recently published a list of the principal equatorial telescopes (refracting and reflecting) of the world. A single glance at it impresses the reader with the thought that this is, indeed, the era of great telescopes as well as enterprises of magnitude in commerce and the arts. While it is true that there is plenty of desirable work to be done in every department of Astronomy within the reach of small telescopes, it is also true that the great questions of the science, and some of the new ones claiming the attention of the astronomer seem to demand better instrumental facilities, if they are to be mastered in the near future. The solar parallax, physical constitution of the *Sun* and attendant phenomena, proper motion of stars, stellar parallax and physical study of the planets are a few examples in which the need is apparent, either in seeing details, or in measuring very small quantities accurately. Naturally enough, the first thing thought of is to make larger telescopes, and improve known methods of study as much as possible, for, a faithful use of the known will certainly lead to that which

is new in kind or principle, before there is waste in the uses of the old. This principle is as rigidly true in Astronomy as in Ethics, because all truth is one and from one Supreme Being.

We first present as complete a list of equatorial refracting telescopes as we are able to do from information at hand. Later a list of large reflecting telescopes may be given.

Following the plan used in the *Astronomical Register* (English), we give only refractors whose apertures are not less than 9.8 inches, for obvious reasons. A * indicates that the telescope is dismounted at present, or that no information as to its having been in use for some time could be obtained; a † that the instrument is in process of construction.

LIST OF REFRACTING TELESCOPES.

Observatory or Owner.	*Aperture.*	*Maker of Object-Glass.*
Rio Janeiro, Brazil	9.8	Henry Bros.
Toulouse, France	9.8	Brunner.
Upsala, Sweden	9.8	Steinheil.*
West Point, New York	9.8	Fitz.*
Leyton (private), England	10.0	Cooke.
Orwell Park (private), Eng.	10.0	Merz.
Col. Knight " "	10.0	Ross.
Fairford " "	10.0	Merz.
O'Gyalla " Hungary.	10.0	Merz.
Hamburg, Germany	10.1	Merz.
Marseilles, France	10.2	(?)
Ancetri, Florence	10.5	Amici.
Paris, France	10.6	Henry Bros.
Constantinople, Turkey	10.6	Plossl.*
Moscow, Russia	10.7	Merz.
Geneva, Switzerland	10.9	Cauchoix. (?)
Ancetri, Florence	11.0	Amici.
Elchies (private)	11.0	Ross.*
Columbia College, New York	11.0	A. Clark.
Copenhagen, Denmark	11.1	Merz & Mahler.*
Munich, Bavaria	11.1	Merz & Mahler.*
Cordoba, Argentine Republic.	11.2	Fitz.

Observatory or Owner.	*Aperture.*	*Maker of Object-Glass.*
Cincinnati, Ohio............	11.25	Merz & Mahler. Clark & Sons.
Sydney, Australia...........	11.4	Schroder.
Cambridge, England.........	11.5	Cauchoix.
Bothkamp.......	11.5	Schroder.
Turin, Italy................	11.5	Merz & Son.†
Potsdam, Prussia...........	11.7	Schroder.
Dunsink, Ireland...........	11.8	Cauchoix.
Sunderland (private), Eng...	12.0	Grubb.
Brooklyn (private), N. Y....	12.0	A. Clark.
Middletown University, Conn.	12.0	A. Clark.
Vienna, Austria.............	12.0	A. Clark & Sons.
Lick Obs'y, Mt. Hamilton, Cal.	12.0	A. Clark & Sons.
Paris, France...............	12.2	Secretan.
Oxford University, England.	12.2	Grubb.
Glasgow, Missouri..........	12.3	A. Clark.
Vassar College, New York...	12.3	A. Clark.
Ann Arbor, Michigan.......	12.5	Fitz.
Algiers....................	12.5	Henry Bros.
Lyon.......................	12.7	Henry Bros.
Greenwich, England........	12.8	Merz.
Dudley Obs'y, Albany, N. Y.	13.0	Fitz.
Allegheny Obs'y, Pa.........	13.0	Fitz.
Columbia College, N. Y.....	13.0	Ruth'd & Fitz.
Cadiz, Spain...............	13.0	Brunner.
Markree Obs'y, Ireland.....	13.2	Cauchoix.
Hamilton Coll., Clinton, N. Y.	13.5	Spencer & Eaton.
Lisbon, Portugal...........	14.6	Merz & Mahler.*
Bordeaux, France...........	14.9	Merz & Son.
Pulkowa, Russia............	14.9	Merz & Mahler.
Nice, France...............	14.9	Henry Bros.
Royal Society, England.....	15.0	Grubb.
Harvard Col., Cambridge, Mass	15.0	Merz & Mahler.
Paris, France...............	15.0	Lerebours.
Rio Janeiro, Brazil.........	15.0	(?)
Madrid, Spain..............	15.0	Merz.
Brussels, Belgium..........	15.0	Merz & Son.

Observatory or Owner.	*Aperture.*	*Maker of Object-Glass.*
Paris, France	15.0	Henry Bros.
Dun Echt, Scotland	15.1	Grubb.
Washburn Obs'y, Mad'n, Wis.	15.5	A. Clark & Sons.
Warner Obs'y, Roch'ter, N. Y.	16.0	A. Clark & Sons.
Vander Zee Obs'y	18.0	(?) Fitz.*
Dearborn Obs'y, Chicago	18.5	A. Clark.
Milan, Italy	19.1	Merz.*
Strassburg, Germany	19.1	Merz.
M. Porro, private (?)	20.5	Porro.*
Buckingham Obs'y (private),	21.2	Buckingham & Wray.*
Etna	21.8	Merz.†
Halsted Obs'y, Prin'ton, N. J.	23.0	A. Clark & Sons.
Newall Obs'y, London, Eng.	25.0	Cooke.
McCormick Obs'y, Univ. of Va.	26.0	A. Clark & Sons.†
Washington	26.0	A. Clark & Sons.
Vienna, Austria	27.0	Grubb.
Paris, France	28.9	Martin. †
Nice, "	29.9	Henry Bros.†
Pulkowa, Russia	30.0	A. Clark & Sons.†
Lick Obs'y, Mt. Hamilton, Cal.	36.0	A. Clark & Sons.†

As might be expected, the mounting of these large object-glasses would present difficulties that might not easily be overcome. One can readily anticipate that the skill of the mechanist might be taxed to make an equatorial mounting heavy enough for stability, and, at the same time, secure that uniform delicacy of motion adapted to the ready and certain measurement of small quantities which high power and large glasses bring to the astronomer's eye. This problem has long been in the observer's mind, and he will watch the trial of these giant telescopes, now in process of construction, with the liveliest interest, to learn if the astronomer can certainly see more and measure better with them than can be done with others of inferior dimensions considering the disadvantages of unwieldy size.

In this direction, it is a pleasure to say that we have greatly profited by a perusal of the late report of Professor SIMON NEWCOMB to the Secretary of the Navy on the recent

improvement in astronomical instruments, already previously noticed in these pages. We give place to his remarks in full concerning the great Russian telescope:

"In 1879, Privy Counsellor OTTO VON STRUVE, director of the Pulkowa observatory, visited this country and contracted with the Messrs. CLARK for the construction of an objective 30 inches in aperture. It was completed and delivered during the year 1882. The mounting is now being completed by the Messrs. REPSOLD, of Hamburg. Although still unfinished, I was desirous of gaining all the information possible respecting its construction, and therefore visited Hamburg for the purpose of examining its parts. The following are some essential points in the structure:

"The most striking feature of the instrument will be the absence of friction rollers from the declination axis. With so large an instrument the friction on the declination axis will be too great to admit of the telescope being conveniently turned either by hand or by rope attached to the two ends, as at Washington and Vienna. The quick motion in declination will be given by a system of cog-wheels turned by an axis passing through the polar axis of the instrument and coincident with it. This axis will be turned by a crank at the lower end, or by the observer taking hold of the circumference of a wheel, at choice. Although the turning of the crank is a more convenient motion for the purpose than that of taking hold of the handles of a steering-wheel, I do not consider it so convenient as pulling a rope. This system of wheel-work will also be connected with the axis of a crank at the eye-piece which the observer can take hold of and turn without leaving the eye-end of the telescope. A second crank will be furnished for the motion in right ascension.

"Instead of using a sector for the clock motion the screw will gear into a complete wheel about two meters in diameter. The trouble of having to turn the sector back will thus be avoided. The illumination of the finding circles and the arrangements for reading them will, in their results, be similar to those used on other large telescopes; that is, the arrangement will be such that the observer can read either circle from the eye-piece. The system of illuminating the field wires, micrometer, position circle, &c., though extensively employed in Europe, is so little known in this country that attention should be called to it. The side of

the telescope at a convenient distance above the eye-end is pierced by an opening on the opposite side from the declination axis. Through this opening passes a conical tube parallel to the declination axis. At the outer end of this tube is a reflector inclined at an angle of 45 degrees to the axis of the cone, but turning on an axis coincident with that of the cone The illuminating lamp shines upon this reflector and turns upon the same axis with it. It is also hung upon gimbals so as to turn upon a secondary axis coincident with the axis of its own line of light. The result of this arrangement is that the lamp always hangs vertically, whatever the position of the telescope, and that the horizontal beam of rays thrown from it always strikes the mirror at an angle of 45 degrees in such a way as to throw the light directly through the conical tube and into the telescope.

"The slightly divergent beam which fills the cone is divided into two or three concentric portions. One of these is reflected upward to the object-glass, and by reflection from the glass itself illuminates the field of view. Another portion shines upon four whitened surfaces around the sides of the micrometer, by which both sets of wires are illuminated. The portion of light which is not needed for this purpose is so arranged as to illuminate the two verniers of the position circle and the heads of the micrometer. So far as I could judge, the working of this plan leaves nothing to be desired in the way of convenience to the observer.

"Worthy of special attention are the eye-piece micrometers now made by the MESSRS. REPSOLD. They include every contrivance necessary for rapid and convenient use.

"*Support of the polar axis.*—Another important feature, which has been applied by the REPSOLDS in their other large instruments, is the method of supporting the polar axis. This axis has to bear a large part of the instrument, counterpoises included. As ordinarily made, it is necessarily subject to an end thrust equal, in our latitude, to two-thirds the weight of the instrument. How to support this thrust without interfering with the ease and freedom of motion has been one of the difficult problems in mounting a telescope. In the REPSOLD instrument the thrust is nearly avoided by supporting the polar axis upon a vertical friction-wheel under the center of gravity of the entire instrument. Counterpoises can be placed at the lower end of the axis so as to balance the instrument upon this wheel. So far as I can judge, this plan leaves nothing to be desired."

The planet *Vesta* was in opposition August 6, 1884.

Investigation of the Repsold Meridian Circle at Strassburg, by DR. W. SCHUR.

In the *Astronomische Nachrichten*, No. 2601, Dr. SCHUR has a very interesting account of the 6-inch REPSOLD circle, of Strassburg.

Dr. SCHUR's investigations began in 1882, with the determination of the division errors of the two-minute circle (A. N. 2532,) of the thread intervals, R. A. micrometer screw, etc.

OBSERVATIONS.

Comparison stars for comets, and the comet 1882 I have been observed.

Since August, 1882, the instrument has been regularly used for the observation of the *Moon*, and *Moon*-culminating stars, etc.

In the beginning of 1883, the *mires* were arranged so that they could be observed by day or by night, and the regular observation of the *Sun* and fundamental stars near it were begun.

Two observers participated in the *Sun* observations, one making the pointings, the other at the microscopes. Each limb of the *Sun* was observed over 5 wires, and pointings were made on both N. and S. limbs. The circle was reversed after each pair of *Sun* observations, thus eliminating possible errors in the thread-intervals; and in Decl. the pointings began with N. and S. limbs alternately. α and δ *Urs. Min.* were regularly observed for the determination of the latitude, and for fixing the azimuth of the line joining the *mires*.

The 303 stars for the Southern Zones of the *Astron. Gesell.*, are next to be observed according to the Leyden programme.

The Mires.—A full description of the mounting of the *mires* is given, and the manner of illuminating them is described. The azimuth of the line joining them has been determined from observations of α and δ *Urs. Min.*, both U. C. and L. C.

In the mean the determinations U. C. and L. C. agree within 0ˢ.02. The two determinations on the same day agree to within about 0ˢ.07 from *Polaris*. The azimuths from the two polars observed on the same day, agree in the mean within about 0ˢ.02. Dr. SCHUR attributes some of the changes in the values of this azimuth to the fact that the pivots were not completely in contact with the Y's. It may be mentioned here that 12 pounds pressure on each Y has been found to be enough weight and not too much, with the circle at Madison.

AZIMUTH OF THE INSTRUMENT.

From the assumption of a constant direction of the line joining the *mires*, the azimuth of the instrument has been computed, and is given in tabular form. The azimuth is thus shown to be remarkably constant. The question of a dependence of the constants on temperature is not examined.

NADIR-POINTS.

After a trial of the method, the horizontal-point determinations from levelled collimators have been abandoned, and recourse had to Nadir observations. The pointings on the Nadir are alternately made N. and S. of the instrument, and a constant difference of 0″.11, has been found between the two sets. No trace of this difference has been found at Madison, and at Strassburg it possibly may have been due to the weight of the observer, transferred from one side to another.

The Nadir point itself appears to be quite constant.

It appears that in spite of all precautions, the floor beams of the meridian circle room were in indirect contact with the piers. This has been remedied.

HORIZONTAL FLEXURE.

This constant has been determined to be 0″.13, but the investigation is not completed.

COLLIMATION.

This is determined by a reversal on the collimator, and appears to be pretty constant.

It is worthy of notice that at the Washburn observatory,

during 1883, a reticle of spider lines (like that at Strassburg) was used. The collimations are given in *Publ. Washburn Observatory*, Vol. II., p. 61. Since 1884, a glass reticle is employed, and the collimations are even steadier.

THE PIVOTS.

The figure of the pivots has been investigated by a collimator in the prime-vertical, and found to be practically perfect.

THE TEMPERATURE.

A very interesting table of temperatures is given, by which the excellence of the construction of the room is shown. The thermometers in the foundations of the piers have varied between 6° C and 10° C.

The whole investigation shows the instrument and its mounting to be of the highest class.

What is part.cularly striking, is the frequency of reversals; and also the fact that reflex observations appear to be unusually difficult to make. EDWARD S. HOLDEN.

A list of recent Comets compiled by Dr. LEWIS SWIFT, *of Warner Observatory, Rochester, N. Y.*

From queries that have been made from time to time by our readers, concerning the more recent comets, it has seemed desirable to present a complete list arranged according to the plan of comet catalogues generally, and which is supplemental to the catalogue found in the last edition of *Chamber's Astronomy.* It will be understood at a glance that the pages of the table facing each other belong together, and are read horizontally across both. The blank columns in the last table are left so for the convenience of those who may wish to write in the data received in the future. Especial care has been taken to get the elements correct, yet some data at hand, Dr. SWIFT thinks may not be the best. Any changes observed by those who give particular attention to this branch, that ought to be made, will receive prompt attention if communicated to us.—ED.]

Year.		Perihelion passage.			Long. of perihel-ion.		Long. of node.		Incli-na-tion.		Perihelion distance.
		m	d	h	°	′	°	′	°	′	
1867	i.	Jan.	19	20	75	52	78	35	18	12	1.5725
"	ii.	May	23	22	236	9	101	10	6	24	1.2870
"	iii.	Nov.	6	23	276	21	64	58	83	26	0.3304
1868	i.	April	20	23	116	2	101	14	29	22	0.5968
"	ii.	June	25	23	287	7	53	40	48	11	0.5823
"	iii.	Sept.	14	16	158	10	334	31	13	6	0.3339
1869	i.	June	10	23	275	55	113	33	10	48	0.7815
"	ii.	Oct.	9	18	123	24	311	29	68	23	1.2306
"	iii.	Nov.	20	19	41	17	192	40	6	55	1.1026
1870	i.	July	14	1	303	32	141	44	58	12	1.0087
"	ii.	Sept.	2	12	17	49	12	56	80	34	1.8171
"	iii.	"	23	0	318	41	146	25	15	39	1.2803
"	iv.	Dec.	19	21	4	8	94	44	32	43	0.3892
1871	i.	June	10	14	141	49	279	18	87	36	0.6543
"	ii.	July	27	0	115	43	211	56	78	0	1.0835
"	iii.	Nov.	30	0	116	5	269	17	54	17	1.0301
"	iv.	Dec.	20	8	147	2	264	30	81	36	0.6944
"	v.	"	28	18	158	12	334	33	13	8	0.3329
1872	i.	Oct.	6	4	109	45	245	50	12	22	0.8600
1873	i.	May	9	1	237	39	78	45	9	44	1.7695
"	ii.	June	25	9	306	10	120	54	12	43	1.3445
"	iii.	July	18	12	50	3	209	39	11	22	1.6826
"	iv.	Sept.	10	19	64	26	230	38	96	0	0.7944
"	v.	Oct.	1	19	50	28	176	43	121	29	0.3849
"	vi.	"	10	12	116	6	101	16	29	23	0.5935
"	vii.	Dec.	1	6	85	43	250	20	30	1	0.7345
1874	i.	Mar.	9	22	300	36	31	31	58	17	0.4394
"	ii.	"	13	23	245	53	274	7	148	25	0.8860
"	iii.	July	8	21	271	6	118	44	66	21	0.6758
"	iv.	Aug.	86	20	344	8	251	30	41	49	0.9827
"	v.	July	17	17	5	26	215	51	34	8	1. 690
"	vi.	Oct.	18	17	298	47	218	38	99	26	0.5197
1875	i.										
1875	ii.										

Eccentricity.	Direction of motion.	Calculator.	Discoverer.	Name of Comet.
0.8490	D	Searle	Tempel	
0.5196	D	Sandberg	"	Tempel's I.
	R	Oppolzer	Bucker	
0.8081	D	Bruhns	Tempel	Brorsen's
	R	Plummer	Winnecke	
0.8491	D	Von Asten	"	Encke's
0.7519	D	Oppolzer	"	Winnecke's
	R	Oppenheim	Tempel	
	D	Bruhns	"	
	R	Dreyer	Winnecke	
	R	Hind	Coggia	
0.6349	D	Leveau	Winnecke	D'Arrest's
	R	Schulhof	"	
0.9978	D	Holetschek.	"	
	R	Schulhof	Tempel	
0.8210	D	Fischer	Borelly	Tuttle's
	R	Schulhof	Tempel	
0.8493	D	Glasenepp	Winnecke	Encke's
0.7559	D			Biela's
0.4620	D	Sandberg	Temple	Tempel's I.
0.5441	D	Plummer	"	Tempel's II.
0.5774	D	Moller		Fay's
	R	Weiss	Borelly	
	R	Weiss	Henry	
0.8089	D	Plummer		Brorsen's
	D	Weiss	Coggia	
		Schulhof	Winnecke	
	R	Weiss	"	
		Schulhof	Coggia	
0.9987		Gruber	Borelly	
0.9622	D	Holetschek.	Coggia	Winnecke's
		Holetschek.	Borelly	Encke's

Year.	PP.	$\pi - \Omega$	Long. Ω	i.	Log. q.
		° ′	° ′	° ′	
1877 i.	Jan. 19.225	347 16	189 20	153 1	9.9071
" ii.	Apr. 17.712	63 9	316 37	121 .8	9.9777
" iii.	Apr. 26.865	116 47	346 4	77 .9	0.0040
" iv.	June 27.093				
" v.	June 27.093	103 19	184 16	115 41	0.0301
" vi.	Sept. 11.408	143 21	250 58	77 42	0.1977
1878 i.	July 21.263	178 02	102 18	78 1	0.1433
" ii.					
" iii.					
1879 i.					
" ii.					
" iii.	Apr. 28.037	3 5	45 34	107 0	9.9489
" iv.	Oct. 4.600	115 19	87 07	77 6	9.9959
" v.	Aug. 29.279	84 10	32 22	107 45	9.996
1880 i.	Jan. 27.611	82 20	359 58	143 34	7.822
" ii.	July 17.184	158 46	260 0	122 35	0.216
" iii.					
" iv.	Sept. 6.963	323 17	45 6	141 50	9.553
" v.	Nov. 18.597	106 17	296 46	5 24	0.027
" vi.	Nov. 9.408	13 21	249 39	60 41	9.830
1881 i.	May 20.597	174 36	125 1	78 51	9.769
" ii.	June 16.370	360 33	270 58	63 26	9.867
" iii.	Aug. 22.774	122 12	96 26	139 50	9.800
" iv.	Sept. 13.829	9 8	269 24	113 47	9.694
" v.	Sept. 12.834	112 1	66 9	6 53	9.860
" vi.	Sept. 14.144	6 21	274 11	112 48	9.652
" vii.					
" viii.	Nov. 17.407	116 30	180 59	144 58	0.284
1882 i.	June 10.308	209 21	204 43	73 .39	8.769
" ii.	Sept. 17.275	69 29	345 58	141 59	7.882
" iii.	Nov. 13.035	254 22	249 7	96 11	9.980
1883 i.	Feb. 20.202	113 19	77 33	280 4	9.879
" ii.					
" iii.					
" iv.	Jan. 25.047	199 20	253 57	74 41	9.878
1884 i.	'83 Dec. 25.34	138 39	264 25	114 59	9.491
" ii.					

Calculator.		Discoverer.		Name of Comet.
Hartwig.		Borelly		
Plath.		Winnecke		
Nichol.		Swift		
				D'Arrest's
Ginzel.		Tenpel		
Plummer.		Coggia		
Holetschek.		Swift		
				Encke's
				Tempel's, II
				Brorsen's
				Tempel's, I
Winnecke.		Swift		
Zelber.		Palisa		
Hartwig.		Hartwig		
Oppenheim.		Gould		
"		Schaeberle		
				Fay's
Oppenheim.		Hartwig		
Chandler.		Swift		Swift's
Chandler.		Pechule		
Zelber.		Swift		
Frisby.		Tebbutt		
Hepperger.		Schaeberle		Encke's
Oppenheim.		Barnard		
Chandler.		Dennning		Denning's
"		Barnard		
				Encke's
Boss.		Swift		
Egbert.		Wells		
Fabritius.		Finlay		
Zelber.		Barnard		
Hepperger.		Brooks		
				D'Arrest's
				Tempel's, II
Oppenheim.		Pons-Brooks		Pons-Brooks'
"		Ross		
		Barnard		

ASTRONOMICAL CLOCKS.*

In most astronomical work of the first class, especially in meridian observations, the perfection of the clock is as necessary as that of any other instrument. But it seems to be an observed fact that no certain way has yet been found of securing an approach to perfection in the rate of the clock. All we can say is, that clocks of marvelous excellence are now and then made, sometimes by one maker and sometimes by another, and that of these clocks some are permanently good while others, in the course of time, deteriorate. I found a few examples of clocks preserving their rate with remarkable uniformity through considerable periods. One of these is the Normal clock of the Berlin observatory, made by TIEDE. It is inclosed in an air-tight case in order to prevent changes of rate arising from variations in the barometric pressure. The temperature compensation is unfortunately imperfect, so that the rate is subject to an annual change. This fact has prevented the exact discussion to which I desired to subject it. It would seem, however, from a cursory examination, the materials for which were courteously afforded me by Professor FORSTER, that the annual change from temperature does not exceed 10 or 15 seconds per year, and that when this is allowed for the differences between the actual and the computed errors will be a very few seconds per year. In recent times the clocks furnished by HOWHU, of Amsterdam, have secured a reputation for uniform excellence which has never been surpassed; that is, instead of being able to occasionally turn out a clock of remarkable excellence, all the clocks of this artist, so far as they have been discussed, are of the first class.

The following exhibit of the observed and computed errors of one of his clocks through a period of nearly two years has been selected, not from a belief that this particular clock was better than others, but because the data for the examination were at hand:

* From Prof. NEWCOMB's report on improvements in astronomical instruments.

Comparison of the observed and computed corrections of Clock Howhu 2:, at the observatory of Leyden, 1865, December 1, to 1867, October 25.

[FORMULA FOR COMPUTED DAILY RATE: $+0^s.759-0^s.03642\,(T-14°)$ $+0^s.0106\,(B-760^{mm})$.
T=temperature, cent.:
B=height of barometer.]

	CORRECTION.		
	Observed.	Computed.	Difference.
1865.	s.	s.	s.
December 1	20.9	20.9	0.0
29	56.3	54.8	+ 1.5
1866.			
January 26	89.1	84.2	+ 4.9
February 23	119.8	112.1	+ 7.7
March 30	161.1	148.0	+13.1
April 27	188.9	172.5	+16.4
May 25	215.3	195.5	+19.8
June 29	236.5	216.0	+20.5
July 27	249.7	231.7	+18.0
August 31	265.0	252.3	+12.7
September 28	277.9	270.0	+ 7.9
October 26	297.4	293.4	+ 4.0
November 30	327.8	326.5	+ 1.3
December 28	356.9	355.9	+ 1.0
1867.			
January 25	385.2	386.5	— 1.3
February 22	414.3	416.1	— 1.8
March 29	452.2	454.5	— 2.3
April 26	476.1	479.1	— 3.0
May 31	505.8	505.3	+ 0.5
June 28	524.7	522.9	+ 1.8
July 26	540.8	539.4	+ 1.4
August 30	559.9	559.5	+ 0.4
September 27	575.4	577.2	— 1.8
October 25	594.6	600.6	— 6.0

In this connection I may be allowed to call attention to the unsatisfactory character of the data usually presented for estimating the excellence of clocks. In my judgment the estimate of the clock should be founded upon its errors,

determined from time to time through a period of not less than a year. These errors should be exhibited in connection with the mean temperature of the clock-room, and if the clock is not in an air-tight case the height of the barometer should also be given. A calculated error should then be carried through the whole period, in which the corrections for temperature and height of the barometer should be introduced. A clock which stands this test well may be presumed beyond doubt to keep its rate during short intervals, which is generally the important point.

It is very common to present as sufficient data for judging of a clock and exhibit of its daily rates from time to time. If these rates were really determined with the last degree of accuracy they might be sufficient for the purpose. But as found in practice they will be the result, not merely of the actual rates of the clock, but of various personal differences among the observers and changes in the pointing of the instrument as well as the accidental errors of observation. From these causes, although the clock were perfect, we might expect an apparent difference of several hundredths of a second between the apparent rate on successive days.

The barometric change in the rates of all clocks of the usual construction is so important a drawback that it should no longer be tolerated in work of the first class. Two methods have been proposed; the one, that already mentioned, of inclosing the clock in an air-tight case; the other, to supply it with a barometric compensation. The latter method is undoubtedly the easiest, but where the necessary perfection of arrangements can be secured the former must be considered greatly preferable. The grounds of preference are that the air can be exhausted from the case to any extent, thus diminishing its resistance to the motion of the pendulum and permitting a diminution in the driving power. Again, if, instead of air, the case be filled with some gas which does not act on the oil, the slow oxidation of the latter may be prevented. It may therefore be expected that under this system a clock could be allowed to remain undisturbed for a longer period than under any other.

How Time Observations are taken with a small Transit at Carleton College Observatory.

By a small transit instrument is meant one whose clear aperture is from two to three inches, and is usually portable, with or without reversing apparatus.

A few suggestions are offered in respect to a convenient way for observing stars to determine the error of the sidereal clock, for the amateur, or for the experienced time-keeper who does not care to go through the usual reductions for each star observed, whenever the clock-error is to be examined. It is supposed that the student understands the theory of the transit instrument well enough to determine accurately the azimuth, collimation and level errors, and that this has been done after placing the instrument in the meridian as nearly as possible. We will assume for the present that other instrumental errors are so small by the skill of the maker, that they need no attention. The observer then determines the equatorial intervals of the wires of the eye-piece as carefully as possibe, by repeated observations of a close circumpolar-star, and writes out the results in convenient tabular form, in the time observing-book, for easy reference, for they will be frequently needed. He then must refer to the *American Ephemeris*, and should have the *Berliner Astronomische Jahrbuch*, which give the mean and apparent places of a large number of well determined stars, from which he can select stars, and group them in sets of four each, according to the plan which is herein to be given.

If the errors of the instrument before named, (azimuth, collimation and level) are small, four stars may be chosen, and their observations so combined, as to reduce these errors so much that they will be wholly unappreciable. The set should consist of two pairs of stars, each pair containing a north and a south star.

The following rough table will suggest the zenith distances of the members of each pair at the place of observation, which will destroy instrumental errors, as before indicated:—

TABLE.

S. Z. D.	N. Z. D.
°	°
0	0
6	5
14	10
25	15
41	20

For this purpose, a star whose south zenith distance is 6° should be observed with one whose north zenith distance is 5°. A south zenith distance of 25° corresponds to a north zenith distance of 15°, and so on throughout the above table. It is undesirable to choose stars for time of greater zenith distance, either north or south, than those of 20° and 41° respectively, for the same reasons that such stars are avoided in other methods, unless observed by fixed instruments whose errors are known.

The best way to illustrate the working of this method is to take a set of stars in use at this observatory, find their a, b, c factors in the ordinary way, and then combine their equations of condition, so as to deduce a single new equation in what a, b and c are practically zero.

The latitude of this observatory is 44° 27′ 40″.8, and its longitude $1^h\ 4^m\ 23^s.8$ west of Washington. One of the star groups used for determining the error of the sidereal clock at the present time is as follows :

Mag.	Name.	*a*	*b*	*c*	*h*	Time.	
					° ′	h m	
2.6	*β Draconis*	+0.226	+1.623	+1.638	82 5	17 28	N.
3.3	*α Herculis*	—0.324	+1.083	+1.130	73 20	17 42	S.
4.0	*θ Herculis*	—0.157	+1.247	—1.256	82 48	17 52	S.
2.3	*γ Draconis*	+0.197	+1.594	—1.606	82 57	17 54	N.

The mean gives — 0.014 + 1.387 — 0.023.

The resulting equation would then read : $T = -0.014a + 1.387b - 0.023c$, in which T is the mean of the observed errors of the four stars, and the signs of the co-efficients of a and c have been previously determined by circum-

polar star observations, or other common methods, and are applied to the stars on any particular occasion as the position of the instrument requires. As the signs are entered in the example above, it is evident that when the transit points south of the zenith, it is also pointing west of the meridian which is indicated by the minus sign. Whatever the error of azimuth is it should be subtracted from the apparent star time to give the true time if only one star, were observed. When the instrument is pointing north of the zenith the sign of azimuth changes, as every one knows, because the great circle of azimuth intersects the meridian in the zenith and nadir points if no other errors exist. The instrument is not reversed in taking the first two stars, hence the sign of collimation will be the same for both, and in the exercise above it is known to be plus, and in this position the instrument under consideration swings in a small circle east of the meridian. Between the second and third stars the transit is reversed which, of course, changes the sign of collimation for the two following stars while the signs for azimuth remain the same. If the level error, represented by *b*, is nearly or quite eliminated at the outset, and remains unchanged throughout the observation of the four stars, no attention is paid to it. It is best, however, to test the level of the instrument before or immediately after observing each star, and when a level correction is necessary apply it as in any other case, for the manner of observing and relating the stars gives no aid in destroying this error, as any observer will readily see.

On the evening of August 14, the above stars were observed for time by the assistant at this observatory, Miss Mary E. Byrd, and the observed clock-error by each star was as follows :

β	*Draconis*	$-35^s.27$
μ	*Herculis*	-35.22
θ	*Herculis*	-35.81
γ	*Draconis*	-35.90
	The mean	-35.55

In as much as the level was steady within a half division

during the entire observation, there was no appreciable correction to apply on this account, though it is to be noticed that small level errors would give nearly maximum effects because three of the stars have small zenith distance.

Now if we take the observed time of each of these four stars and apply to it the instrumental errors of collimation and azimuth, we have the following results:

Star.	Obs. Error.	a	c		Corr't Error.
β *Draconis.*	$-35^s.27$	$+0^s.07$	$-0^s.33$	=	$-35^s.53$
μ *Herculis,*	-35.22	-0.10	-0.22	=	-35.54
θ *Herculis,*	-35.81	-0.05	$+0.25$	=	-35.61
γ *Draconis,*	-35.90	$+0.06$	$+0.32$	=	-35.52

The mean of the corrected observations is -35.55

It is of course accidental that the mean of the corrected observations in this example is the same to a hundreth of a second as the mean of the uncorrected ones, for the errors of observation certainly would not warrant so close an agreement of values generally. It should, however, be said that the above set of stars is not especially well or ill related, as will be seen by examining the final equation of condition. It works only fairly well. It is also true that the observations of August 14, were taken for this illustration only because they were the last taken preceding this writing and were consequently at hand for the purpose. That night was unfavorable for observation. The stars were "woolly" and unsteady, so that the middle wire of a group of seven was corrected in the observation of each star as much as one-tenth of a second, which is considerably larger than ordinary observing gives.

The instrument used was a transit of three inches aperture, by Messrs. FAUTH & COMPANY, Washington, D. C., and is only in fair condition for work. Its azimuth error is about $0^s.3$, while the error of collimation varies only a little from $0^s.2$. These errors were obtained by taking the mean of many observations of the *Sun*, circumpolar-stars, and high and low stars. Fairly good results were obtained. The reductions given above were all made by the use of the ordinary formulæ:

$$\text{R. A.} = \text{T}+\text{dt}+a\,\frac{\sin\,(\varphi-\delta)}{\cos\,\delta}+b\,\frac{\cos\,(\varphi-\delta)}{\cos\,\delta}+\frac{c}{\cos\,\delta}$$

in which,

R. A.=the right ascension of the star.
T=observed time.
dt=correction for error of clock.
a=azimuth.
b=level error.
c=collimation.
φ=latitude.
δ=declination.

The rate of the sidereal clock was $-0^s.25$ per day and hence *dt* would be too small to take notice of during less than one hour's observation.

Star-sets like the one given above, may be arranged for every month in the year, and when put in convenient form very much simplify the labor of accurate time-keeping under almost any circumstance now in mind in connection with important observatory work.

Professor H. A. HOWE of the University of Denver, some time ago called our attention to these points. The method may be in use elsewhere; if so, we are not aware of it.

THE DOUBLE-STAR 85 PEGASI.

We have in this one of the most interesting binary systems in the heavens. Its discovery * is attributed to the French astronomer, FLAMMARION, at whose request I began, at Chicago the study of the double, by measure, and its motion is rapid as one may see:

MEASURES OF THE TWO REMOTE STARS A=6.; C=9.0.

Epoch.	Angle.	Distance.	
	°	"	
1855.00	105.0	30.0	Argelander.
1870.00	77.0	16.0	Brunnow.
1877.94	49.8	14.0	Flammarion.
1878.54	33.6	14.4	Burnham.
1879.27	30.4	15.0	"
1880.57	25.0	15.4	"
1881.54	20.8	16.3	"
1882.77	17.1	17.3	"

* The history of this discovery is curious on account of more than one claim. But perhaps Mr. BURNHAM does not yet know the precedence, at least he may not have read the printed note on page 172 of our work, *The Stars*.

It was in seeking the measures asked by the French astronomer that I discovered the companion of the principal star. This couple is very close and very difficult, even with the 18½-inch equatorial ($0^m.47$). These are the measures:

MEASURES OF THE CLOSE COUPLE. A=6; B=11.

Epoch.	Angle. °	Distance. ″	
1878.73	274.0	0.67	Burnham.
1879.46	284.6	0.75	"
1880.59	298.3	0.65	"
1881.54	311.5	0.58	"
1882.	in contact.	meas. impossible.	"
1883.75	333.	in contact.	"

These measures show already nearly 60° of revolution since 1878. At this rate the entire period will require only 30 years for completion. This is one of the shortest periods we know of among the systems of double-stars.

S. W. BURNHAM,
Astronomer at Chicago.

Remark.—This close couple forms a physical system in rapid orbital motion. On the contrary, the more distant star is independent of this pair, and will always remain stationary. It was employed in 1870 by the Astronomer BRUNNOW, as a point of reference in measuring the annual parallax of the star 85 *Pegasi*. The parallax was found to be only 0″.054, which gives the distance about 3,805,000 times the radius of the Earth's orbit, or about 129 *trillions* of leagues. At the rate of 75,000 leagues per second, it would require not less than 64½ years for light to reach us from it. If this parallax were certain (but it is so very small that it is uncertain,) and if the mean distance of the small star were about 0″.7, as an element of the absolute orbit, the period of thirty years would give for the mass of this system compared with the *Sun*:

$$\text{Distance A B} = \frac{0.7}{0.054} = 12.9$$

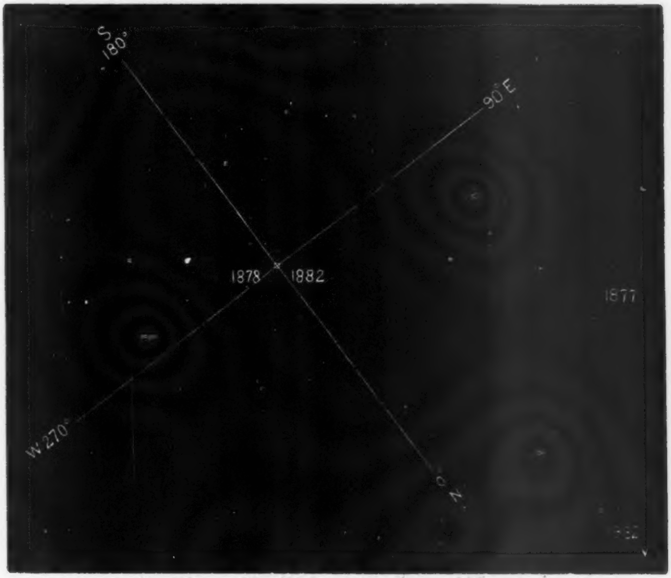
(the radius of the Earth's orbit being 1).

$T = \sqrt{(12.9)^3} = 46.4$ years for one planet of our system.

$$\frac{46.4}{30}=1.55$$
$$\mu=(1.55)^2=2.40.$$

This small system will accordingly be two and one-half times the mass of the *Sun*. But evidently this is only the first very premature approximation.

The discovery of the learned American astronomer, however, reveals, at once, a new world before which the whole Earth is only a shadow.



The Binary System of the Double-Star 85 Pegasi and distant star. (Scale: $4^{mm}=1''$)

This group is represented in the (accompanying) figure by a scale of 4^{mm} to $1''$. The arrow indicates the motion of the distant star in perspective from the first special measure made by us in 1877 to the last made by Mr. Burnham in 1882.

In reality, it is not the star that moves: it is the binary system that moves in an opposite direction.—*L'Astronomie.*

C. F.

EDITORIAL NOTES.

We issue No. 27 for September, this year, ahead of time, that hereafter the volume may begin with January which doubtless will be agreeable to all concerned.

W. F. DENNING discusses the great red spot of *Jupiter* in the August number of the *Astronomical Register*. During the opposition just past the motion of the spot as observed at Bristol, England, is about the same as noticed at the previous opposition of 1882-3, so that now there appears to be no increase in retrograde motion, in longitude, as was seen from 1879 to 1882, but on the contrary its motion is uniformly retarded. The spot is still visible, but faint, especially in its outlines. It is a singular fact noticed by Mr. DENNING, that as the spot has grown faint during the last two years its retrograde motion has been diminishing.

Professor HOUGH of Dearborn observatory, who has given special attention to the markings of *Jupiter*, observed the outlines of the great spot in May last, and speaks of them as being sharply defined still and entirely separate from any belt. It is certain that its color is very much fainter than when first seen in 1878. It is possible, as Professor HOUGH suggested in 1883, that this is the same spot that has appeared and vanished eight times between 1665 and 1708. "In 1664-6 a great red spot was observed by HOOK and CASSINI. It was situated one-third of the semi-diameter of the planet south of the equator in latitude 6°. Its diameter was one-tenth of the diameter of *Jupiter*, or about 8000 miles. * * * If the ancient observation extending over half a century refers to the same object, we would naturally infer that it was a portion of the solid body of the planet; being sometimes rendered invisible by a covering of clouds."

MR. DAVID GILL, astronomer at the Cape, in a late lecture at the Royal Institution on "Recent Researches on the Distances of the Fixed Stars," etc., as reported by the *Astronomical Register*, said:

> "Art is long and life is short," and that in the long run careful observations are superior to the most brilliant speculations. He would not, however, undervalue the imaginative mind which seeks after truth; for without it no man was fitted for the work to be done, or can be sustained during the watches of the night in his noble labor of love.

Speaking of the history of stellar parallax he said that previous to 1832 the parallax of no fixed star had been rendered sensible. Between 1835 and 1838 the parallax of *α Lyræ* was found to be one-fourth of a second of arc, a quantity as difficult to determine as it would be to measure a globe one foot in diameter at a distance of eighty miles.

It was also said that the earth's orbit from the star 61 *Cygni* would appear as small as a silver three-penny a mile away.

"These early measurements were taken by ascertaining the changes of position of certain stars in relation to each other; but the first to make a direct measurement of their parallax was HENDERSON of the Cape observatory; the second was BESSEL. Of late years Dr. GILL and a young American astronomer, Dr. ELKIN, had been measuring the distances of some fixed stars in the southern hemisphere by means of a telescope with a divided object-glass (heliometer), and with the following results as expressed in the number of years in which light travels from them to the earth: *Alpha Centauri* 4.36 years; *Sirius* 8.6; *Lacaille* (9352) 11.6; *Epsilon Indi* 15.0; o^2 *Eridani* 19.1; *Epsilon Eridani* 23.0; *Xi Toucanæ* 54.0. So far as observations have yet gone *α Centauri* is the nearest of the fixed stars, and eye-observations as to the relative brilliancy of stars are no guide to their relative true distances."

It is further stated in the *Astronomical Register* for August that Dr. GILL believes with Mr. LOCKYER that the future progress of this branch of astronomy will depend much on photography. It is estimated that it would take ten years to make a complete photographic map of the heavens, and it is said, that Dr. ELKIN is willing to do the work in the northern hemisphere, and Mr. GILL in the southern, if the necessary apparatus can be supplied.

In the matter of parallax of the stars the results of careful study of *α Lyræ* and 61^2 *Cygni* by Professor HALL of the Washington observatory, from observations of 1880 and 1881 may be properly appended. They are as follows:

α Lyræ	18.11	Julian years.
61^2 *Cygni*	6.803	" "

The parallax of the former was found to be 0".1797; of the latter 0".4783.

DR. DUBJAGO of the observatory at Pulkowa, has published the first orbit that we have seen, for Mr. BURNHAM'S binary star, *Beta Delphini*. Since 1873, the time of its discovery, more than 180° of the orbit have been described. The entire period as found by Dr. DUBJAGO is 26.07 years. There are but two known double-stars with less period than this. They are 42 *Comæ Berenices* whose time is 25.71 years, and *Delta Equulei* to which Mr. BURNHAM gives the marvelously short period of 10.8 years. The study of the binary and multiple star systems is intensely interesting.

E. E. BARNARD of Nashville, rightly enjoys another triumph which has come from skill and care in observation. It will be remembered that we have often spoken of the small star preceding *Beta Capricorni* which Mr. BARNARD observed some time ago while it was being occulted by the *Moon*. The strange appearance it presented during the phenomenon led him to believe that it was a close double-star, but his instrument was too small to divide it. It was also tried by

some large telescopes, though under unfavorable circumstances, and its duplicity was not made out, so that several good observers were inclined to think that Mr. BARNARD's explanation of the star's appearance was wrong.

As the star came into favorable position this year, it was examined by Professor HOUGH and Mr. BURNHAM of Dearborn observatory, Chicago, during the last days of July, and by the aid of the 18½-inch refractor it was clearly seen to be double. The measures given by the above named observers are:

Position Angle 108°.6
Distance 0″.86

BRORSEN's Comet of short period is again near the time of its perihelion passage. We have seen no published ephemeris of its return. It is stated in a recent copy of *Nature*, "that the perturbations since its last appearance in 1879, will not have been very material, and the mean motion of that year would fix the time of the approaching perihelion passage near September 14.5 G. M. T. If the longitudes of Dr. SCHULZE's orbit for 1879 are brought up to 1884.75, the following expressions for the comet's heliocentric co-ordinates result:

$$x = r[9.94286] \sin (v + 207^\circ\ 56'.7)$$
$$y = r[9.98506] \sin (v + 126\ \ 22.0)$$
$$z = r[9.73705] \sin (v + 60\ \ 33.4)$$

Taking September 14.5 for the epoch of perihelion passage, the comet's approximate positions are:

12h. G. M. T.	R. A.	Decl.	Distance from Earth.	Sun.
	h. m.	° ′		
August 24	7 58.0	+10 37	1.284	0.720
" 26	8 11.0	11 10		
" 28	8 24.2	11 40	1.295	0.679
" 30	8 37.5	12 8		
Sept. 1	8 51.0	+12 33	1.312	0.644

If we suppose an acceleration of four days in the time of perihelion passage, the effect on the geocentric position is:

On August 16 in R. A. +15^m.1; in Decl. +2° 1′
On August 28 in R. A. +16 .7; in Decl. 1 41

In 1873 when the circumstances approached nearest to those of the return of the present year, the comet was detected at Marseilles, on the morning of September 2, the distance from the earth being 1.02, and that from the *Sun* 0.94, the intensity of light 1.08. At the last appearance it was seen by TEMPEL at Arcetri, on January 14, when the intensity of light was only 0.13, an exceptional case, since at no previous appearance had it been observed under less value than 0.33.

From the first discovery of the comet in 1846 by BRORSEN, an astronomical amateur at Kiel, the period of revolution has gradually diminished from the effect of the planetary perturbations; subjoined are the times of perihelion passage in those years when the comet

has been observed, and the sidereal periods corresponding to those times:

				Days.
1846	Feb.	25.37	G. M. T.	2034.1
1857	March	29.25	"	2022.7
1868	April	17.41	"	2002.4
1873	Oct.	10.48	"	1944.4
1879	March	30.54	"	1994.9

From its unfavorable position the comet was missed at its returns in 1851 and 1862.

It is well known that the present orbit was due to the action of the planet *Jupiter* in 1842: at the perijove passage at 6 P. M. on May 27 in that year, the comet's distance from *Jupiter* was 0.0547 of the earth's mean distance from the *Sun*; consequent on its near approach the inclination of the orbit in which it previously moved was diminished nearly 15° according to the calculations of Dr. HARZER, who has very fully investigated the consequences. It is probable that there had been a great perturbation in the elements from the same cause in 1759–60, and that in 1937 (according to D'ARREST) this may occur again."

The last volume (47) of the Memoirs of the Royal Astronomical Society is at hand. It contains the following important papers:

1. On the *Moon's* photographic diameter, and on the applicability of celestial photography to accurate measurement, by Professor C. PRITCHARD.

2. Observations of the transit of *Venus*, 1874 Dec. 8–9, Colony of Victoria, Australia, communicated by R. L. J. ELLERY, Government astronomer.

3. (Title same as last); made at stations in New South Wales; communicated by H. C. RUSSELL, Government astronomer, Sidney.

4. (Title as above); made at Windsor, New South Wales, by JOHN TEBBUTT.

5. (Title as above); made at Adelaide, New South Wales, by CHAS. TODD.

6. (Title as above), as observed at Mooltan, Punjab, India, by A. C. BRIGG-WITHER.

7. (Same as given above); made at the Cape of Good Hope; communicated by E. J. STONE, Royal astronomer at the Cape.

8. Measures of SIR JOHN HERSCHAL'S Cape stars together with a list of new double-stars, by H. C. RUSSELL.

9. Double-star observations made in 1879 and 1880 with the 18½-inch of the Dearborn observatory, Chicago, by SHERBURNE WESLEY BURNHAM.

10. On solar motion in space, by WILLIAM E PLUMMER.

11. Photometric determination of the relative brightness of the brighter stars north of the equator, by Prof. C. PRITCHARD.

The volume has five full-page plates illustrating phenomena

attendant upon the transit of *Venus*, and closes with a list of persons to whom the medals or testimonials of the society have been adjudged.

The treatment of photography as a means of accurate measurement, in the first paper of this volume is clear, full and very conclusive.

As a simple illustration of how this means of measuring was studied to give knowledge of its accuracy, and therefore confidence in it, we notice one table shows that a large number of micrometric measures were taken between prominent points widely separated on the lunar surface (arbitrarily and variously selected), and that these measures were compared with those of the corresponding points in the image impressed on the photographic film. And it was shown by the small residuals in the comparison, that "the photographic film and the visual telescopic image were for all purposes of measurement interchangeable." The photographs were taken and the measures made which were intended for comparison by different instruments and at times as nearly simultaneous as possible.

The points carefully studied in this valuable paper are:

1. The reliability of instrumental means and of the angular measures obtained therefrom.

2. The reliability of telescopic fields over which the measures extend.

3. The practical identity of the photographic image with the telescope image itself.

4. The effect of the irregularities on the *Moon's* limb.

5. The effect, if any, of temperature, time of exposure, motion of the *Moon* in declination, altitude of the *Moon*, or of any other suspicious circumstances, likely to modify the image impressed on the film.

Volume II of the publications of Washburn observatory is at hand. It is a companion to volume one in appearance, though much larger, as it contains nearly 400 pages. Large space is given to the study of the new REPSOLD Meridian Circle, in which every important part of that instrument apparently has been tested by severe trial and rigid scrutiny. We have before spoken favorably of the way the work of the REPSOLDS on this instrument has so far stood the tests to which it has been subjected during the last year.

The Hohwu sidereal clock is the standard for other time-pieces of the observatory and the extended time service given to railway and telegraph companies. This clock, though lacking in some minor adjustments at the present time, is apparently one of excellence, as will be seen from a comparison of computed and observed rates, in one hundred cases from January, 1882, to December, 1883, in which it is shown that the sum of the one hundred residuals taken without

regard to sign was $14^s.28$, giving an average residual of 0^s14. This is a surprisingly accurate record for a new or old time-piece. Professor HOLDEN also states that the average daily error of railway time-signals was

For	September,	1883,	$0^s.08$
"	October,	"	0.07
"	November,	"	0.11
"	December,	"	0.06

This interesting report also gives a list of one hundred and eleven new double-stars and two nebulæ encountered in the sweeps from September, 1881, to January, 1884. Observations of one hundred and nineteen red or colored stars between 1881, Dec. 26, and 1883, Dec. 31, being a continuation of work reported in Vol. I.; occultation of forty stars by the *Moon;* the reduction of the star-gauges of Sir WILLIAM HERSCHEL to 1860.0, (first series Nos. 1—683); tables showing the counts of stars from the manuscript charts of Dr. C. H. F. PETERS, Professor J. C. WATSON and from CHACORNAC's charts compiled by Dr. PETERS; an interesting paper by Mr. GEORGE C. COMSTOCK, on a new method of observing with the Prime Vertical transit; investigations of the micrometer of the fifteen-inch equatorial by Mr. JOHN TATLOCK, and a full series of meteorological observations at Madison during 1882-1883.

From the annual report of the Observatory of Paris which is just received, some interesting facts pertaining to the work of 1883, are presented. In the department of meridian service, special attention has been given to the observation of the stars of LELANDE's catalogue. In addition to this, the large planets, minor planets, comparison stars for equatorial work and the *Moon* have been observed. Four meridian instruments have been employed in this service. Special study of the errors of the new circle one of the meridian instruments, began in December, 1882, and ended in July, 1883. The fundamental positions of 60° and 120° have been examined three hundred times, those from 20° to 20° forty times, from 5° to 5° thirty times, from degree to degree twenty times, and finally the positions of 5°, six times. Flexure has been carefully determined.

During the year the GAMBEY telescope has been furnished with a zenith collimator for the purpose of determining collimation in zenith position, and consequently, the lateral flexure as ascertained by comparing the values of collimation at the zenith and horizon.

Curious experiments were made with what is called a bath of mercury amalgam. A square basin of silvered copper $0^m.15$ on the side, with layer of mercury $0^{mm}.6$ deep, showed that jars from the street and in the room scarcely affected the mercury. The only inconvenience resulting from its use was the fact, that the mercury amalgam was somewhat dull and its power of reflection was diminished. The surface seemed to be normal, and this device was used even with portable instruments.

The two large equatorials in use at this observatory are respectively 14 and 12 inches. The larger instrument has been repaired, and is now provided with new and needed attachments. With the smaller instrument, Mr. BIGOURDAN has observed 150 days in nine months. The objects studied were the Great Comet of 1882, Comet Brooks, Comet Pons-Brooks, and eleven of the minor planets, besides 400 observations of double-stars, occultations and eclipses of *Jupiter's* satellites. The report also gives considerable space to meteorology, meteorological instruments and local observations with the same.

The *Oakland Daily Evening Tribune* (Aug. 9), contains a long article particularly descriptive of the great observatory founded by Mr. JAMES LICK and located on Mt. Hamilton, Cal. Later important parts of this description will be given; we now have space only to notice what is said about the costly glasses which will distinguish the great equatorial as by far the most powerful refracting telescope in existence. The writer says: "On the extreme end and south of the observatory building will be the dome of the great 36-inch equatorial. The diameter of the dome will be 70 feet; the length of the instrument 60 feet, and the cost of the same $101,000. FEIL & Co. of Paris, sub-contractors with ALVAN CLARK & SONS, have succeeded in casting one of the disks which is now being worked by the CLARKS at Cambridgeport, Mass., but the Paris contractors after trying nineteen times to cast the second disk have not yet been successful. The cost of the object-glass when ready for its place in the telescope will be $51,000, and the probable cost of the mounting will be an additional $50,000, making a total as given above."

A curious phenomenon was noticed on the evening of July 30, by many residents of the neighborhood of Philadelphia. Several independent accounts have been forwarded. Perhaps it can be best described by the following letter written by an intellegent doctor of Atlantic City, N. J.:

"About five minutes before 10:00 in the evening I first saw what for a few minutes I thought was a narrow thin white cloud, extending from a point about 30° above the horizon in the west to perhaps 20° beyond the zenith in the east. It struck me at first as looking like the tail of a comet, but this I hardly thought possible, until after watching it a few minutes I found it moving bodily across the sky. In 20 minutes the western end had reached the zenith; the whole thing seemed rather shorter, the eastern end possibly a little fainter. The whole thing passed from view in about 30 to 35 minutes from the time I first saw it. The form, exactly that of a large comet, was maintained throughout. Neither end seemed to the naked eye brighter than the other." I. S.

THE RED SKIES.

If the phenomenon of our red skies is due to the volcanic eruption in Java, and the proof seems to point to that as a cause, my frequent observations of bright rapidly moving particles near the *Sun* can read-

ily be explained, on the supposition that they were minute particles of ashes drifting through the atmosphere, which had their origin in the awful catastrophe of Krakatoa. Though great numbers of these floating bodies were visible in the instrument, the number too small to be seen must have been far greater. Around the *Sun* to a distance of 15°, the sky has presented a greenish appearance. The outer border of this glare of light is always terminated by a brick-dust reddish ring, showing that the phenomenon of morning and evening attends the *Sun* for the entire day. During the first part of the year, the red glow preceded the rising of the full *Moon*, though of course not so conspicuous as in the case of the *Sun*, indicating that it does not exist simply in the direction of the *Sun*, for the full *Moon* appears almost constantly surrounded by a pearly glare, resembling that around the *Sun*.

E. E. B.

H. E. MATHEWS, Secretary of the Board of Trust of Lick observatory, 606 Montgomery st., San Francisco, Cal., has himself taken a number of interesting photographic views pertaining to Lick observatory and its surroundings. The pictures are about 4½ inches by 7½ inches in size, and are neatly mounted. The following are some of the prominent features represented:

Lick Avenue, at Junction House. five miles from San Jose; Grand View of Lick Avenue; Lick Observatory from Middle Peak; Mount Hamilton, Middle Peak; Lick Observatory, Front View; Interior, long North Hall; Lick Observatory, Small Dome; Lick Observatory, Central Roof; and more than forty others, making a desirable collection of views of this great observatory.

From the August number of *L'Astronomie* (French), it appears that the observers PAUL and PROSPER HENRY of the observatory of Paris, have made important observations of the surface markings on the planet *Uranus*. They have seen two gray belts, straight and parallel, situated nearly symmetrically on opposite sides of the diameter of the planet's disc. Between these lies a bright zone which probably corresponds to the equatorial region of the planet. The two polar regions are dark, the upper in the telescope appearing brighter than the other. As the result of a large number of measures, these observers have found that the direction of the bands of *Uranus* do not coincide with the projection of the major axis of the apparent orbit of the satellites, but forms with it an angle of 40°. Thus, the angles of position observed are: 56° for the bands and 16° for the projection of the major axis for the same epoch.

A new minor planet was discovered by J. PALISA of Vienna, Aug. 18, 1884. Its magnitude is 13, and its position, at the time,

R. A. $22^h\ 9^m\ 38^s$.
Decl. $-5°\ 30'\ 25''$

Motion in R. A.= — 12′; in Decl.= —7′.

This is number (239). No. (237) is called *Coelestina*. No. (238) is waiting for a name.

JOHN TATLOCK, JR., has been appointed Director of Smith observatory, Beloit College, Wis., and is already at his post. The choice is a wise one.

In our list of recent comets the Egyptian Comet, as it is called, was inadvertently omitted. No serious omission, however, for it was but once seen, if memory serves us rightly.

Messrs. WM. BOND & SON, chronometer and watch-makers, Boston, Mass., have removed their place of business from 97 Water st. to 112 State st. This house has earned its solid reputation by a prosperous business for nearly a century past in Boston.

Subscriptions and orders for the MESSENGER received in August: Messrs. E. STEIGER & Co., P. O. box 298, New York City, Vol. I., Nos. 1, 4, 7, 8, 9; Vols. II. and III., LEVI K. FULLER, Brattleboro, Vt., J. C. MCCLURE, Red Wing, Minn., C. W. SEELEY, Box 266, Eastport, Maine; JOHN TATLOCK, Jr., Smith observatory, Beloit, Wis.

BOOK NOTICE.

Epitome of Ancient, Mediæval, and Modern History, By Carl Ploetz. Translated, with extensive additions, by William H. Tillinghast, of the Harvard University Library. Boston: Houghton, Mifflin & Co., 1884. Crown, 8vo., pp. 618.

Prof. Dr. CARL PLOETZ'S "Auszug aus der Geschichte" has passed through many editions in Germany, and has taken rank as the best book to be found for the purposes for which it was intended. It is a complete dictionary of chronology, and yet it is better than any mere dictionary could be; for it not only gives prominence to the prominent events and shows the relations of the subordinate events by the use of different types, but it gives more than a bare list of events. By a remarkably good arrangement it packs an immense amount of historical information into a comparatively small space. As the translator says:

"The distinguishing feature of the epitome is the arrangement whereby a *brief connected narrative* is accompanied by a clear, well-graduated chronology which emphasizes the sequence of events without breaking up the story or fatiguing the mind."

Valuable as is the original work, the labors of the translator and his associate, Dr. EDWARD CHANNING, have added much to its value, especially in giving to English and American history the fullness that the author reserved for the history of his fatherland.

An index of more than fifty closely printed pages completes the work, rendering accessible for ready reference the contents of the book. We commend the work most heartily, as one indispensable to the student and teacher of history. C. H. C.